Answers to Numerical Questions

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A2.1 Check and Reflect

10. a) phosphorus will gain 3 electrons
b) sodium will lose 1 electron
c) chlorine will gain 1 electron
d) magnesium will lose 2 electrons
e) iodine will gain 1 electron

11.

Element Name	Mass Number	Number of Protons	Number of Neutrons
calcium	41	20	21
uranium	238	92	146
aluminium	27	13	14
beryllium	9	4	5
neon	19	10	9
iron	53	26	27

12.

Atom or Ion Name	Overall Charge	Number of Protons	Number of Electrons	Symbol	Number of Electrons Lost or Gained
oxygen atom	0	8	8	O	0
oxide ion	2-	8	10	O^{2-}	gained 2
potassium ion	1+	19	18	K^{+}	lost 1
magnesium ion	2+	12	10	Mg^{2+}	lost 2
fluoride ion	1-	9	10	F^{-}	gained 1
calcium ion	2+	20	18	Ca^{2+}	lost 2
aluminium ion	3+	13	10	Al^{3+}	lost 3

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Practice Problem

1. a) $MgCl_{2(s)}$
b) $Na_2S_{(s)}$
c) $Ca_3P_{2(s)}$
d) $K_3N_{(s)}$
e) $CaF_{2(s)}$

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Practice Problem

2. a) iron(III) chloride
b) lead(IV) oxide
c) nickel(III) sulfide
d) copper(II) fluoride
e) chromium(III) sulfide

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Practice Problems

3. a) $Ba(OH)_{2(s)}$
b) $Fe_2(CO_3)_{3(s)}$
c) $CuMnO_{4(s)}$

4. a) gold(III) nitrate
b) ammonium phosphate
c) potassium dichromate

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Practice Problem

5. a) carbon dioxide
b) dinitrogen monoxide
c) phosphorus trichloride
d) $OF_{2(g)}$
e) $N_2S_{4(s)}$
f) $SO_{3(g)}$

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A2.2 Check and Reflect

3. a) Na^{+}
b) Ca^{2+}
c) Ag^{+}
d) Cu^{2+}
e) Pb^{4+}
f) Cl^{-}
g) ClO_3^{-}
h) ClO_2^{-}
i) CH_3COO^{-}
j) NH_4^{+}

4. a) aluminium ion
b) potassium ion
c) zinc ion
d) nickel(III) ion
e) iron(II) ion
f) iron(III) ion
g) hydrogencarbonate ion
h) hydroxide ion
i) thiocyanate ion
j) sulfite ion

5. a) methane
b) ammonia
c) water
d) hydrogen sulfide
e) hydrogen fluoride

8. a) aluminium chloride
b) calcium sulfide
c) sodium nitride
d) potassium sulfate
e) lithium oxide
f) iron(III) iodide
g) lead(IV) nitrate
h) copper(I) phosphate
i) ammonium nitrite
j) sodium acetate (or sodium ethanoate)

9. a) $NaOH_{(s)}$
b) $(NH_4)_2SO_{3(s)}$
c) $Mg(SCN)_{2(s)}$
d) $CaHPO_{4(s)}$
e) $Al(CH_3COO)_{3(s)}$
f) $CrCl_{3(s)}$

10. a) $N_2O_{4(g)}$
b) $PCl_{5(g)}$
c) $NI_{3(s)}$
d) $CO_{(g)}$
e) $P_4O_{10(s)}$
f) $CS_{2(g)}$
g) $SO_{3(g)}$
h) $CH_{4(g)}$
i) $NH_{3(g)}$
j) $C_6H_{12}O_{6(s)}$

11. a) carbon tetrabromide
b) nitrogen monoxide
c) oxygen difluoride
d) iodine monobromide
e) selenium dibromide
f) phosphorus trichloride
g) dinitrogen trioxide
h) sulfur dichloride

12. a) hydrogen peroxide
b) iron(III) thiocyanate
c) $C_2H_5OH_{(l)}$
d) $Na_2SiO_{3(s)}$
e) $NH_4ClO_{4(s)}$
f) sulfur hexafluoride

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A2.4 Check and Reflect

4. a) $HNO_{3(aq)}$
b) $CsOH_{(s)}$
c) $CH_3COOH_{(aq)}$
d) $Ca(OH)_{2(s)}$
e) $HCl_{(aq)}$
f) $H_3PO_{4(aq)}$
g) potassium hydroxide
h) hydrobromic acid
i) sulfuric acid
j) magnesium hydroxide

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A2.0 Section Review

23. a) sodium will lose 1 electron
b) fluorine will gain 1 electron
c) calcium will lose 2 electrons
d) nitrogen will gain 3 electrons
e) oxygen will gain 2 electrons

24. a) cesium chloride
b) potassium nitride
c) sodium oxide
d) aluminium nitride
e) magnesium sulfide
f) lithium phosphide
g) aluminium oxide
h) silver fluoride
i) iron(II) bromide
j) lead(IV) chloride
k) nickel(III) oxide
l) gold(III) nitride

25. a) ammonium sulfide
b) ammonium sulfate
c) calcium nitrate
d) aluminium hydrogencarbonate
e) sodium silicate
f) chromium(II) chlorite
g) lead(IV) hydrogenphosphate
h) potassium permanganate
i) sodium dichromate
j) aluminium acetate or ethanoate
k) cobalt(II) benzoate
l) ammonium thiocyanate

26. a) $NaBr_{(s)}$
b) $Ca_3N_{2(s)}$
c) $MgO_{(s)}$
d) $AlCl_{3(s)}$
e) $RbI_{(s)}$
f) $Li_3P_{(s)}$
g) $FeS_{(s)}$
h) $Cr_3N_{2(s)}$
i) $Cu_2O_{(s)}$
j) $TiBr_{4(s)}$
k) $PbF_{2(s)}$
l) $CoN_{(s)}$

27. a) $Li_2CO_{3(s)}$
b) $Be(NO_3)_{2(s)}$
c) $Na_3PO_{4(s)}$
d) $NH_4CN_{(s)}$
e) $NaHCO_{3(s)}$
f) $AlBO_{3(s)}$
g) $Mn(ClO_4)_{2(s)}$
h) $Fe(OH)_{3(s)}$
i) $Cu(C_6H_5COO)_{2(s)}$
j) $Au(SCN)_{3(s)}$
k) $Pb(CrO_4)_{2(s)}$
l) $CrPO_{3(s)}$

28. a) dinitrogen monoxide
b) sulfur trioxide
c) phosphorus pentachloride
d) $CBr_{4(l)}$
e) $SCl_{6(g)}$
f) $OF_{2(g)}$
g) nitrogen triiodide
h) water
i) ammonia
j) $CH_{4(g)}$
k) $P_4O_{10(s)}$
l) $XeF_{2(g)}$

31. a) hydrofluoric acid
b) nitric acid
c) sodium hydroxide – base
d) methanoic acid or formic acid
e) ammonium hydroxide – base
f) ethanoic acid or acetic acid
g) phosphoric acid
h) calcium hydroxide – base

36. a) $Ca(NO_3)_{2(s)}$
b) $Al(OH)_{3(s)}$
c) $CH_3OH_{(l)}$
d) $PBr_{3(g)}$
e) ammonium carbonate
f) sulfur dichloride
g) tin(II) chloride
h) strontium chloride
i) $NaCH_3COO_{(s)}$
j) $Pb(CH_3COO)_{4(s)}$
k) $H_2O_{2(l)}$
l) $C_6H_{12}O_{6(s)}$

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A3.1 Check and Reflect

10. 14.5 g

11. 6.7 g

12. a) 57.4 g
b) 42.6 g

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Practice Problem

1. a) $N_{2(g)} + 3\ H_{2(g)} \longrightarrow 2\ NH_{3(g)}$
b) $CaC_{2(s)} + 2\ H_2O_{(l)} \longrightarrow Ca(OH)_{2(s)} + C_2H_{2(g)}$
c) $SiCl_{4(s)} + 2\ H_2O_{(l)} \longrightarrow SiO_{2(s)} + 4\ HCl_{(aq)}$
d) $2\ H_3PO_{4(aq)} + 3\ CaSO_{4(s)} \longrightarrow Ca_3(PO_4)_{2(s)} + 3\ H_2SO_{4(aq)}$

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A3.2 Check and Reflect

7. a) $2\ Al_{(s)} + 3\ F_{2(g)} \longrightarrow 2\ AlF_{3(s)}$
b) $4\ K_{(s)} + O_{2(g)} \longrightarrow 2\ K_2O_{(s)}$
c) $C_6H_{12}O_{6(s)} + 6\ O_{2(g)} \longrightarrow 6\ CO_{2(g)} + 6\ H_2O_{(g)}$
d) $H_2SO_{4(aq)} + 2\ NaOH_{(s)} \longrightarrow Na_2SO_{4(aq)} + 2\ H_2O_{(l)}$
e) $Mg(CH_3COO)_{2(aq)} + 2\ AgNO_{3(aq)} \longrightarrow Mg(NO_3)_{2(aq)} + 2\ AgCH_3COO_{(s)}$
f) $2\ H_2O_{2(aq)} \longrightarrow O_{2(g)} + 2\ H_2O_{(l)}$

8. a) $CH_{4(g)} + 2\ O_{2(g)} \longrightarrow CO_{2(g)} + 2\ H_2O_{(g)}$
b) $2\ NaCl_{(s)} \longrightarrow 2\ Na_{(s)} + Cl_{2(g)}$
c) $Ca(NO_3)_{2(aq)} + Na_2SO_{4(aq)} \longrightarrow 2\ NaNO_{3(aq)} + CaSO_{4(s)}$
d) $H_{2(g)} + CO_{(g)} \longrightarrow C_{(s)} + H_2O_{(g)}$ (balanced)
e) $2\ Na_{(s)} + 2\ H_2O_{(l)} \longrightarrow 2\ NaOH_{(aq)} + H_{2(g)}$
f) $2\ CaCO_{3(s)} + 2\ SO_{2(g)} + O_{2(g)} \longrightarrow 2\ CaSO_{4(s)} + 2\ CO_{2(g)}$
g) $S_{8(s)} + 8\ O_{2(g)} \longrightarrow 8\ SO_{2(g)}$
h) $Ca_3(PO_4)_{2(s)} + 3\ H_2SO_{4(aq)} \rightarrow 2\ H_3PO_{4(aq)} + 3\ CaSO_{4(s)}$
i) $2\ KClO_{3(s)} \longrightarrow 2\ KCl_{(s)} + 3\ O_{2(g)}$

9. a) $Ca_{(s)} + 2\ HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + H_{2(g)}$
b) $Mg_3N_{2(s)} + 6\ H_2O_{(l)} \longrightarrow 3\ Mg(OH)_{2(aq)} + 2\ NH_{3(g)}$
c) $H_2SO_{4(aq)} + 2\ NaOH_{(s)} \longrightarrow Na_2SO_{4(aq)} + 2\ H_2O_{(l)}$
d) $2\ NO_{2(g)} \longrightarrow N_2O_{4(g)}$
e) $CuCl_{2(aq)} + 2\ NaOH_{(aq)} \longrightarrow Cu(OH)_{2(s)} + 2\ NaCl_{(aq)}$

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Practice Problems

2. skeleton: $Li_{(s)} + O_{2(g)} \longrightarrow Li_2O_{(s)}$
balanced: $4\ Li_{(s)} + O_{2(g)} \longrightarrow Li_2O_{(s)}$

3. skeleton: $Pb_{(s)} + Br_{2(l)} \longrightarrow PbBr_{4(s)}$
balanced: $Pb_{(s)} + 2\ Br_{2(l)} \longrightarrow PbBr_{4(s)}$

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Practice Problem

4. a) calcium nitride, $Ca_3N_{2(s)}$
b) silver oxide, $Ag_2O_{(s)}$
c) aluminium fluoride, $AlF_{3(s)}$

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Skill Practice: Formation Reactions

1. a) potassium iodide
b) magnesium phosphide
c) cesium chloride
d) calcium oxide
e) aluminium sulfide

2. a) $Na_{(s)} + Br_{2(l)} \longrightarrow NaBr_{(s)}$
b) $Mg_{(s)} + F_{2(g)} \longrightarrow MgF_{2(s)}$
c) $Al_{(s)} + Cl_{2(g)} \longrightarrow AlCl_{3(s)}$
d) $K_{(s)} + N_{2(g)} \longrightarrow K_3N_{(s)}$
e) $Ca_{(s)} + P_{4(s)} \longrightarrow Ca_3P_{2(s)}$

3. a) $4\ Li_{(s)} + O_{2(g)} \longrightarrow 2\ Li_2O_{(s)}$
b) $2\ Al_{(s)} + 3\ Br_{2(l)} \longrightarrow 2\ AlBr_{3(s)}$
c) $Hg_{(l)} + I_{2(s)} \longrightarrow HgI_{2(s)}$
d) $2\ Na_{(s)} + Cl_{2(g)} \longrightarrow 2\ NaCl_{(s)}$
e) $3\ Mg_{(s)} + N_{2(g)} \longrightarrow Mg_3N_{2(s)}$
f) $Ni_{(s)} + F_{2(g)} \longrightarrow NiF_{2(s)}$

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Practice Problem

5. a) $8\ MgS_{(s)} \longrightarrow 8\ Mg_{(s)} + S_{8(s)}$
b) $2\ KI_{(s)} \longrightarrow 2\ K_{(s)} + I_{2(s)}$
c) $2\ Al_2O_{3(s)} \longrightarrow 4\ Al_{(s)} + 3\ O_{2(g)}$
d) $NiCl_{2(s)} \longrightarrow Ni_{(s)} + Cl_{2(g)}$

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Practice Problem

6. a) $CH_{4(g)} + 2\ O_{2(g)} \longrightarrow CO_{2(g)} + 2\ H_2O_{(g)}$

b) $2\ C_2H_{6(g)} + 7\ O_{2(g)} \longrightarrow 4\ CO_{2(g)} + 6\ H_2O_{(g)}$

c) $C_3H_{8(g)} + 5\ O_{2(g)} \longrightarrow 3\ CO_{2(g)} + 4\ H_2O_{(g)}$

d) $2\ C_6H_{6(l)} + 15\ O_{2(g)} \longrightarrow 12\ CO_{2(g)} + 6\ H_2O_{(g)}$

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Practice Problems

7. Word equation: chlorine + nickel(III) bromide → nickel(III) chloride + bromine

Skeleton equation: $Cl_{2(g)} + NiBr_{3(aq)} \longrightarrow NiCl_{3(aq)} + Br_{2(l)}$

Balanced equation: $3\ Cl_{2(g)} + 2\ NiBr_{3(aq)} \longrightarrow 2\ NiCl_{3(aq)} + 3\ Br_{2(l)}$

8. Word equation: zinc + silver nitrate ⟶ zinc nitrate + silver

Skeleton equation: $Zn_{(s)} + AgNO_{3(aq)} \longrightarrow Zn(NO_3)_{2(aq)} + Ag_{(s)}$

Balanced equation: $Zn_{(s)} + 2\ AgNO_{3(aq)} \longrightarrow Zn(NO_3)_{2(aq)} + 2\ Ag_{(s)}$

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Skill Practice: Decomposition and Single Replacement Reactions

Activity Notes

1. a) magnesium phosphide ⟶ magnesium + phosphorus

b) sodium chloride ⟶ sodium + chlorine

c) strontium oxide ⟶ strontium + oxygen

d) zinc + iron(II) chloride ⟶ iron + zinc chloride

e) aluminium + copper(II) iodide ⟶ copper + aluminium iodide

f) magnesium + gold(III) nitrate ⟶ gold + magnesium nitrate

2. a) $CaO_{(s)} \longrightarrow Ca_{(s)} + O_{2(g)}$

b) $NaF_{(s)} \longrightarrow Na_{(s)} + F_{2(g)}$

c) $Mg_3N_{2(s)} \longrightarrow Mg_{(s)} + N_{2(g)}$

d) $Fe_{(s)} + Cu(NO_3)_{2(aq)} \longrightarrow Cu_{(s)} + Fe(NO_3)_{3(aq)}$

e) $Cl_{2(g)} + NaI_{(aq)} \longrightarrow I_{2(s)} + NaCl_{(aq)}$

f) $Pb_{(s)} + AgNO_{3(aq)} \longrightarrow Ag_{(s)} + Pb(NO_3)_{2(aq)}$

3. a) $2\ FeCl_{3(s)} \longrightarrow 2\ Fe_{(s)} + 3\ Cl_{2(g)}$

b) $2\ Cu_2O_{(s)} \longrightarrow 4\ Cu_{(s)} + O_{2(g)}$

c) $2\ LiBr_{(s)} \longrightarrow 2\ Li_{(s)} + Br_{2(l)}$

d) $3\ Br_{2(l)} + 2\ CrI_{3(aq)} \longrightarrow 2\ CrBr_{3(aq)} + 3\ I_{2(s)}$

e) $2\ AgNO_{3(aq)} + Cu_{(s)} \longrightarrow 2\ Ag_{(s)} + Cu(NO_3)_{2(aq)}$

4. a) bromine + iron(III) iodide ⟶ iron(III) bromide + iodine

$Br_{2(l)} + FeI_{3(aq)} \longrightarrow FeBr_{3(aq)} + I_{2(s)}$

$3\ Br_{2(l)} + 2\ FeI_{3(aq)} \longrightarrow 2\ FeBr_{3(aq)} + 3\ I_{2(s)}$

b) magnesium + gold(III) fluoride ⟶ magnesium fluoride + gold

$Mg_{(s)} + AuF_{3(aq)} \longrightarrow MgF_{2(aq)} + Au_{(s)}$

$3\ Mg_{(s)} + 2\ AuF_{3(aq)} \longrightarrow 3\ MgF_{2(aq)} + 2\ Au_{(s)}$

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Activity A10 Inquiry Lab

Analyzing and Interpreting

4. $4\ Fe_{(s)} + 3\ O_{2(g)} \longrightarrow 2\ Fe_2O_{3(s)}$

8. a) $Mg_{(s)} + 2\ AgNO_{3(aq)} \longrightarrow 2\ Ag_{(s)} + Mg(NO_3)_{2(aq)}$

b) $Cu(NO_3)_{2(aq)} + Mg_{(s)} \longrightarrow Mg(NO_3)_{2(aq)} + Cu_{(s)}$

c) $2\ AgNO_{3(aq)} + Cu_{(s)} \longrightarrow 2\ Ag_{(s)} + Cu(NO_3)_{2(aq)}$

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Practice Problem

9. a) Word equation:

copper(I) nitrate + potassium bromide ⟶ copper(I) bromide + potassium nitrate

Skeleton equation: $CuNO_{3(aq)} + KBr_{(aq)} \longrightarrow CuBr_{(s)} + KNO_{3(aq)}$

Balanced equation: $CuNO_{3(aq)} + KBr_{(aq)} \longrightarrow CuBr_{(s)} + KNO_{3(aq)}$

b) Word equation:

aluminium chloride + sodium hydroxide ⟶ aluminium hydroxide + sodium chloride

Skeleton equation: $AlCl_{3(aq)} + NaOH_{(aq)} \longrightarrow Al(OH)_{3(s)} + NaCl_{(aq)}$

Balanced equation: $AlCl_{3(aq)} + 3\ NaOH_{(aq)} \longrightarrow Al(OH)_{3(s)} + 3\ NaCl_{(aq)}$

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Activity A11 Quicklab

1–3. a) sodium iodide + silver nitrate ⟶ sodium nitrate + silver iodide

$NaI_{(aq)} + AgNO_{3(aq)} \longrightarrow NaNO_{3(aq)} + AgI_{(s)}$

b) iron(III) chloride + sodium hydroxide ⟶ sodium chloride + iron(III) hydroxide

$FeCl_{3(aq)} + 3\ NaOH_{(aq)} \longrightarrow 3\ NaCl_{(aq)} + Fe(OH)_{3(s)}$

c) sodium carbonate + calcium chloride ⟶ sodium chloride + calcium carbonate

$Na_2CO_{3(aq)} + CaCl_{2(aq)} \longrightarrow 2\ NaCl_4 + CaCO_{3(s)}$

d) no precipitate

e) silver nitrate + sodium carbonate ⟶ sodium nitrate + silver carbonate

$2\ AgNO_{3(aq)} + Na_2CO_{3(aq)} \longrightarrow 2\ NaNO_{3(aq)} + Ag_2CO_{3(s)}$

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Practice Problem

10. a) $C_4H_{10(g)} + O_{2(g)} \longrightarrow CO_{2(g)} + H_2O_{(g)}$

b) $Ca(NO_3)_{2(aq)} + Na_3PO_{4(aq)} \rightarrow Ca_3(PO_4)_{2(s)} + NaNO_{3(aq)}$

c) $Ca_{(s)} + AgNO_{3(aq)} \longrightarrow Ca(NO_3)_{2(aq)} + Ag_{(s)}$

d) $Mg_{(s)} + O_{2(g)} \longrightarrow MgO_{(s)}$

e) $AlCl_{3(s)} \longrightarrow Al_{(s)} + Cl_{2(g)}$

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Activity A12 Quicklab

1. copper(II) chloride + aluminium $\longrightarrow$ aluminium chloride + copper

$3\ CuCl_{2(aq)} + 2\ Al_{(s)} \longrightarrow 2\ AlCl_{3(aq)} + 3\ Cu_{(s)}$

4. calcium chloride + sodium carbonate $\longrightarrow$ calcium carbonate + sodium chloride

$CaCl_{2(aq)} + Na_2CO_{3(aq)} \longrightarrow CaCO_{3(s)} + 2\ NaCl_{(aq)}$

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Practice Problems

11. Word equation: lead(IV) nitrate + zinc $\longrightarrow$ zinc nitrate + lead

Skeleton equation: $Pb(NO_3)_{4(aq)} + Zn_{(s)} \longrightarrow Zn(NO_3)_{2(aq)} + Pb_{(s)}$

Balanced equation: $Pb(NO_3)_{4(aq)} + 2\ Zn_{(s)} \longrightarrow 2\ Zn(NO_3)_{2(aq)} + Pb_{(s)}$

12. $3\ Ag_{(s)} + Au(NO_3)_{3(aq)} \longrightarrow 3\ AgNO_{3(aq)} + Au_{(s)}$

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A3.3 Check and Reflect

1. a) $CaCl_{2(s)} \longrightarrow Ca_{(s)} + Cl_{2(g)}$ (balanced)

b) $Mg(ClO_4)_{2(s)} + 2\ Na_{(s)} \longrightarrow 2\ NaClO_{4(s)} + Mg_{(s)}$

c) $2\ NaN_{3(s)} \longrightarrow 2\ Na_{(s)} + 3\ N_{2(g)}$

d) $Ca(NO_3)_{2(aq)} + Cu_2SO_{4(aq)} \longrightarrow CaSO_{4(s)} + 2\ CuNO_{3(aq)}$

e) $2\ C_5H_{10(l)} + 15\ O_{2(g)} \longrightarrow 10\ CO_{2(g)} + 10\ H_2O_{(g)}$

f) $Li_4C_{(s)} + 2\ Ca_{(s)} \longrightarrow 4\ Li_{(s)} + Ca_2C_{(s)}$

g) $PbO_{2(s)} \longrightarrow Pb_{(s)} + O_{2(g)}$ (balanced)

h) $CH_{4(g)} + 2\ O_{2(g)} \longrightarrow CO_{2(g)} + 2\ H_2O_{(g)}$

i) $2\ Li_{(s)} + Cl_{2(g)} \longrightarrow 2\ LiCl_{(s)}$

j) $3\ NaI_{(aq)} + AlCl_{3(aq)} \longrightarrow 3\ NaCl_{(aq)} + AlI_{3(s)}$

2. a) $Na_2SO_{4(aq)} + CaCl_{2(aq)} \longrightarrow 2\ NaCl_{(aq)} + CaSO_{4(s)}$

b) $3\ Mg_{(s)} + N_{2(g)} \longrightarrow Mg_3N_{2(s)}$

c) $Sr(OH)_{2(aq)} + PbBr_{2(aq)} \longrightarrow SrBr_{2(aq)} + Pb(OH)_{2(s)}$

d) $2\ Ni(NO_3)_{3(aq)} + 3\ Ca_{(s)} \longrightarrow 3\ Ca(NO_3)_{2(aq)} + 2\ Ni_{(s)}$

e) $CH_{4(g)} + 2\ O_{2(g)} \longrightarrow CO_{2(g)} + 2\ H_2O_{(g)}$

f) $4\ Na_{(s)} + O_{2(g)} \longrightarrow 2\ Na_2O_{(s)}$

g) $N_{2(g)} + 3\ H_{2(g)} \longrightarrow 2\ NH_{3(g)}$

h) $2\ HCl_{(aq)} \longrightarrow H_{2(g)} + Cl_{2(g)}$

i) $2\ AlI_{3(aq)} + 3\ Br_{2(l)} \longrightarrow 2\ AlBr_{3(aq)} + 3\ I_{2(s)}$

j) $2\ H_2O_{(l)} + 2\ Na_{(s)} \longrightarrow 2\ NaOH_{(aq)} + H_{2(g)}$

3. a) $Li_2O_{(s)}$

b) $Cu_{(s)}$ and $Cl_{2(g)}$

c) $Al_2(SO_4)_{3(aq)}$ and $Cu_{(s)}$

d) $Ca(NO_3)_{2(aq)}$ and $PbBr_{2(s)}$

e) $CO_{2(g)}$ and $H_2O_{(g)}$

f) $AgCl_{(s)}$ and $KNO_{3(aq)}$

g) $N_{2(g)}$ and $I_{2(s)}$

h) $S_{8(s)}$ and $LiCl_{(aq)}$

i) $Al_2S_{3(s)}$

j) $CO_{2(g)}$ and $H_2O_{(g)}$

4. $3\ Zn_{(s)} + N_{2(g)} \longrightarrow Zn_3N_{2(s)}$

5. $2\ HgO_{(s)} \longrightarrow 2\ Hg_{(l)} + O_{2(g)}$

6. $2\ C_6H_{6(l)} + 15\ O_{2(g)} \longrightarrow 12\ CO_{2(g)} + 6\ H_2O_{(g)}$

7. $Br_{2(l)} + CaI_{2(aq)} \longrightarrow CaBr_{2(aq)} + I_{2(s)}$ (balanced)

8. $Pb(NO_3)_{2(aq)} + 2\ NaI_{(aq)} \longrightarrow 2\ NaNO_{3(aq)} + PbI_{2(s)}$

9. $HCl_{(aq)} + NaOH_{(s)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$

10. $C_{12}H_{22}O_{11(s)} + 12\ O_{2(g)} \longrightarrow 12\ CO_{2(g)} + 11\ H_2O_{(g)}$

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Practice Problems

13. 32.05 g/mol

14. 142.05 g/mol

15. 44.01 g/mol

16. 149.12 g/mol

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Practice Problems

17. 2.0×10^2 g

18. 2.00 mol

19. 85.2 mol

20. 0.135 mol

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A3.4 Check and Reflect

5. a) 6.0×10^{23} gold atoms

b) 1.5×10^{24} helium atoms

c) 6.02×10^{24} $H_{2(g)}$ molecules

d) 3.78×10^{23} $CO_{2(g)}$ molecules

6. a) 1.2 mol

b) 0.50 mol

c) 2.29 mol

d) 1.711 mol

e) 0.928 mol

7. a) 59 g

b) 44 g

c) 90 g

d) 3.50 kg

e) 0.191 g

8. a) 1 mol

b) 6 g

c) 1.20×10^{25} molecules

9. 31.8 g

10. 3.34×10^{25} molecules of water

11. 2.4×10^{24} atoms

13. $CH_{4(g)} + 2\ O_{2(g)} \longrightarrow CO_{2(g)} + 2\ H_2O_{(g)}$

30 moles of water

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A3.0 Section Review

9. a) 3.00 mol
b) 55.49 mol
c) 0.500 mol
d) 0.2824 mol
e) 0.0102 mol

10. a) 0.20 kg
b) 0.36 kg
c) 202 g
d) 36.7 g
e) 427 g

12. a) $3\ Br_{2(l)} + 2\ Al_{(s)} \longrightarrow 2\ AlBr_{3(s)}$
b) $(NH_4)_2CO_{3(s)} + Ca(NO_3)_{2(aq)} \longrightarrow 2\ NH_4NO_{3(aq)} + CaCO_{3(s)}$
c) $NaOH_{(s)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$ (balanced)

13. a) $2\ KBrO_{3(s)} \longrightarrow 2\ KBr_{(s)} + 3\ O_{2(g)}$
b) $2\ C_2H_{2(g)} + 5\ O_{2(g)} \longrightarrow 4\ CO_{2(g)} + 2\ H_2O_{(g)}$
c) $4\ AuCl_{3(aq)} + 3\ Pb_{(s)} \longrightarrow 3\ PbCl_{4(aq)} + 4\ Au_{(s)}$
d) $6\ K_{(s)} + N_{2(g)} \longrightarrow 2\ K_3N_{(s)}$
e) $Sn(NO_3)_{4(aq)} + 2\ Ca(OH)_{2(s)} \longrightarrow 2\ Ca(NO_3)_{2(aq)} + Sn(OH)_{4(s)}$

14. a) $F_{2(g)} + Ca_{(s)} \longrightarrow CaF_{2(s)}$ (balanced)
b) $3\ Cl_{2(g)} + 2\ NiBr_{3(aq)} \longrightarrow 2\ NiCl_{3(aq)} + 3\ Br_{2(l)}$
c) $2\ C_5H_{10(g)} + 15\ O_{2(g)} \longrightarrow 10\ CO_{2(g)} + 10\ H_2O_{(g)}$
d) $2\ KBr_{(s)} \longrightarrow 2\ K_{(s)} + Br_{(l)}$
e) $AlF_{3(aq)} + Na_3PO_{4(aq)} \longrightarrow AlPO_{4(s)} + 3\ NaF_{(aq)}$

16. 4.60 g

17. $9.03 \times 10^{23}\ CO_{2(g)}$ molecules

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Unit A Project

1. magnesium + hydrochloric acid $\longrightarrow$ magnesium chloride + hydrogen
$Mg_{(s)} + 2\ HCl_{(aq)} \longrightarrow MgCl_{2(s)} + H_{2(g)}$

2. magnesium sulfate + sodium carbonate $\longrightarrow$ sodium sulfate + magnesium carbonate
$MgSO_{4(aq)} + Na_2CO_{3(aq)} \longrightarrow Na_2SO_{4(aq)} + MgCO_{3(s)}$

3. magnesium carbonate $\longrightarrow$ magnesium oxide + carbon dioxide
$MgCO_{3(s)} \longrightarrow MgO_{(s)} + CO_{2(g)}$

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Unit A Unit Review

14.

Element	Mass Number	Protons	Neutrons
carbon	13	6	7
bromine	79	35	44
bromine	81	35	46
chlorine	36	17	19
iron	57	26	31
sodium	33	11	22

15.

Atom or Ion	Overall Charge	Protons	Electrons	Symbol
sulfur atom	0	16	16	S
sulfide ion	2–	16	18	S^{2-}
lithium ion	1+	3	2	Li^{+}
oxide ion	2–	8	10	O^{2-}
chloride ion	1–	17	18	Cl^{-}
iron(II) ion	2+	26	24	Fe^{2+}
nitride ion	3–	7	10	N^{3-}

22. a) $Cl_{2(g)} + 2\ KBr_{(aq)} \longrightarrow 2\ KCl_{(aq)} + Br_{2(l)}$
b) $4\ Li_{(s)} + O_{2(g)} \longrightarrow 2\ Li_2O_{(g)}$
c) $2\ C_2H_{6(g)} + 7\ O_{2(g)} \longrightarrow 6\ H_2O_{(g)} + 4\ CO_{2(g)}$
d) $6\ Na_{(s)} + N_{2(g)} \longrightarrow 2\ Na_3N_{(s)}$
e) $2\ (NH_4)_3PO_{4(aq)} + 3\ Ca(NO_3)_{2(aq)} \longrightarrow 6\ NH_4NO_{3(aq)} + Ca_3(PO_4)_{2(s)}$
f) $CaCO_{3(s)} \longrightarrow CaO_{(s)} + CO_{2(g)}$ (balanced)

33. a) $LiCl_{(s)}$
b) $Ba_3N_{2(s)}$
c) $ZnO_{(s)}$
d) $Ag_2CO_{3(s)}$
e) $Ca(NO_2)_{2(s)}$
f) $RbHSO_{4(s)}$
g) $Cd_3(PO_4)_{2(s)}$
h) $Co(OH)_{3(s)}$
i) $Cu(MnO_4)_{2(s)}$
j) $CrO_{3(s)}$
k) $Fe(ClO_3)_{3(s)}$

34. a) sodium phosphide
b) magnesium sulfide
c) beryllium chloride
d) ammonium sulfide
e) cesium nitride
f) zinc iodide
g) iron(II) fluoride
h) iron(III) hydrogen sulfide
i) gold(I) nitrate
j) lead(IV) permanganate
k) sodium acetate or sodium ethanoate

35. a) $N_2S_{(g)}$
b) $SBr_{2(g)}$
c) $ClF_{(g)}$
d) $H_2S_{(g)}$
e) $CH_{4(g)}$
f) $PCl_{5(g)}$

36. a) tetraphosphorus decaoxide
b) nitrogen dioxide
c) nitrogen trichloride
d) xenon hexafluoride
e) hydrogen peroxide
f) ammonia

46. a) $I_{2(s)} + Hg_{(l)} \longrightarrow HgI_{2(s)}$
b) $2\ K_3PO_{4(aq)} + 3\ Sr(OH)_{2(aq)} \longrightarrow 6\ KOH_{(aq)} + Sr_3(PO_4)_{2(s)}$
c) $Mg_{(s)} + 2\ HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}$

47. a) $CaI_{2(s)} + 2\ AgNO_{3(aq)} \longrightarrow Ca(NO_3)_{2(aq)} + 2\ AgI_{(s)}$
b) $2\ C_6H_{14(l)} + 19\ O_{2(g)} \longrightarrow 12\ CO_{2(g)} + 14\ H_2O_{(g)}$
c) $MgCO_{3(s)} \longrightarrow MgO_{(s)} + CO_{2(g)}$ (balanced)
d) $3\ Li_2SO_{3(aq)} + 2\ Au(NO_3)_{3(aq)} \longrightarrow 6\ LiNO_{3(aq)} + Au_2(SO_3)_{3(s)}$
e) $16\ Cs_{(s)} + S_{8(s)} \longrightarrow 8\ Cs_2S_{(s)}$
f) $2\ Al_{(s)} + 3\ CuSO_{4(aq)} \longrightarrow Al_2(SO_4)_{3(aq)} + 3\ Cu_{(s)}$

48. a) Skeleton equation: $CaF_{2(aq)} + I_{2(s)} \longrightarrow CaI_{2(aq)} + F_{2(g)}$
Balanced equation: $CaF_{2(aq)} + I_{2(s)} \longrightarrow CaI_{2(aq)} + F_{2(g)}$
b) Skeleton equation: $RbI_{(s)} \longrightarrow Rb_{(s)} + I_{2(s)}$
Balanced equation: $2\ RbI_{(s)} \longrightarrow 2\ Rb_{(s)} + I_{2(s)}$
c) Skeleton equation: $C_3H_{8(g)} + O_{2(g)} \longrightarrow CO_{2(g)} + H_2O_{(g)}$
Balanced equation: $C_3H_{8(g)} + 5\ O_{2(g)} \longrightarrow 3\ CO_{2(g)} + 4\ H_2O_{(g)}$
d) Skeleton equation: $Cu(ClO_4)_{2(aq)} + Li_3PO_{4(aq)} \longrightarrow LiClO_{4(aq)} + Cu_3(PO_4)_{2(s)}$
Balanced equation: $3\ Cu(ClO_4)_{2(aq)} + 2\ Li_3PO_{4(aq)} \longrightarrow 6\ LiClO_{4(aq)} + Cu_3(PO_4)_{2(s)}$
e) Skeleton equation: $Zn_{(s)} + FeBr_{3(aq)} \longrightarrow ZnBr_{2(aq)} + Fe_{(s)}$
Balanced equation: $3\ Zn_{(s)} + 2\ FeBr_{3(aq)} \longrightarrow 3\ ZnBr_{2(aq)} + 2\ Fe_{(s)}$

49. a) 2.00 moles
b) 0.5002 moles
c) 4.000 moles
d) 0.00177 moles
e) 83 moles

50. a) 216 g
b) 1.0×10^2 g
c) 3.2×10^2 g
d) 736 g
e) 83.3 g

54. a) sodium oxide
b) aluminium oxalate
c) methanol
d) $NH_4HOOCCOO_{(s)}$
e) $C_3H_{8(g)}$
f) $Ru(H_2PO_4)_{4(s)}$
g) dinitrogen tetroxide
h) tungsten(VI) dichromate
i) osmium(VIII) oxide
j) $C_6H_{12}O_{6(s)}$
k) $Pt(CN)_{4(s)}$
l) $Na_2S_2O_{3(s)}$

56. a) 1.2×10^{24} Al atoms
b) 2.17×10^{25} $SO_{3(g)}$ molecules
c) 1.4×10^{22} $He_{(g)}$ atoms

57. a) 0.155 mol
b) 2.71 mol
c) 0.65 mol

page 128
Practice Problems

1. 1.1×10^2 m/s
2. 5.76×10^4 s
3. 28 m

page 130
Practice Problem

4. b) 5.0×10^2 m/s

page 132
Skill Practice: Using Significant Digits

1. a) 5
b) 6
c) 5
d) 2
e) 2

2. a) 5.3 cm
b) 3.0 km
c) 3.55 km^2
d) 21 km/h

3. a) 6.83×10^{-4}
b) 122
c) 6.2×10^4
d) 0.06

page 133
Practice Problem

5. b) 0 m/s^2
c) 50 m

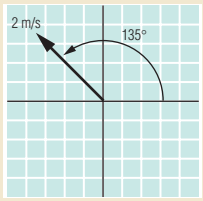
page 135–136
B1.1 Check and Reflect

8. 4.17 m/s
9. 1.50 s
10. 4.06×10^3 km
11. 5.00 h

12. a) 5 m/s
13. a) 0
14. c) 9.0 cm/s
15. c) 6.3 cm
16. 1.80 m/s
17. 1.78 m/s

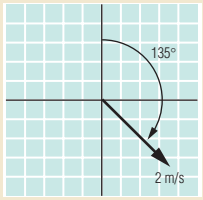
page 139
Practice Problem

6.



page 140
Practice Problem

7.



page 141
Practice Problems

8. a) 22.0 m [E]
b) 1.47 m/s [E]
9. 112 m [N]
10. 0.444 h

page 143
Practice Problem

11. b) 25 m/s [E]

page 145
B1.2 Check and Reflect

3. vector 1 = [60°]
vector 2 = [215°]
4. vector 1 = [30°]
vector 2 = [245°]
5. a) 25.0 m
b) 5.0 m [N]
c) 1.56 m/s
d) 0.313 m/s [N]
6. b) slope_1 = 52 cm/s [E]
slope_2 = –52 cm/s [W]

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Practice Problems

12. 13 m/s^2 [up]
13. 50 m/s^2
14. 333 m/s^2
15. –2.50 m/s^2 [E]

page 154
B1.3 Check and Reflect

5. –5.0 m/s^2 [N]
6. –3.75 m/s^2 [W]
7. 0.250 m/s^2
8. 7.80 m/s [N]
9. 5.01 s
10. c) 2.00 cm/s^2

page 160
Practice Problems

18. 9.75×10^5 J
19. 2.3×10^3 N

page 160
Practice Problem

20. 2.2×10^4 J

page 161
B1.4 Check and Reflect

6. a) 147 J
b) 50.0 J
c) 0.200 J
7. 13.4 N
8. 16.7 m
9. 39.0 J
10. a) 5.0×10^3 J

page 162–163
B1.0 Section Review

8. a) 15.0 J
9. 1.62 m/s
10. 292 m
11. 5.25 h
12. b) 0.00 m/s^2
c) about 100 m
13. a) 7.0 m
b) –3.0 m [W]
14. a) vector A = 75°
vector B = 140°
b) vector A = 15°
vector B = 310°
15. a) 800 m
b) 200 m [N]
c) 3.20 m/s
d) 0.800 m/s [N]
16. b) 3.00 m/s [N]
17. 0.563 m/s^2
18. –12.0 m/s [W]
19. 3.00 s
21. 20 N [E]
22. 600 J
23. 1.1×10^2 J
24. 35.0 N
27. 103 km/h [E]

page 174
Practice Problem

1. 981 J

page 175
Practice Problems

2. 5.99 m
3. 49.9 kg

page 178
B2.2 Check and Reflect

4. a) 96.0 J
b) 96.0 J
5. 129 N
6. 1.48 m
7. 375 J
8. 3.20×10^3 N
9. 2.06×10^3 J

page 179
Practice Problems

4. 1.82×10^{-20} J
5. 7.4 kg

page 181
Practice Problems

6. 45.0 m/s
7. 2.2 m/s

page 182
B2.3 Check and Reflect

5. a) 36.0 J
b) 6.00×10^4 J
c) 39.2 J
6. 20.0 kg
7. a) 4.00 m/s
b) 0.470 m/s
10. a) 80.0 J
b) 160 J

page 183
Practice Problems

8. 97.9 J
9. 1.09×10^3 J
10. 899 J

page 184
Practice Problems

11. 15.3 m/s
12. 0.130 m

page 185
Practice Problems

13. 0.313 J
14. 1.40 m/s

pages 186–187
Activity B9 Inquiry Lab

7. 2.40 m/s
9. 2.88 J
10. 2.88 J
15. 2.40 m/s
17. 2.88 J
18. 2.88 J

page 189
B2.4 Check and Reflect

5. a) 4.00 J
d) 4.00 J
e) 28.3 m/s
f) 4.00 J
g) 40.8 m
6. 4.23 m/s
7. 4.16 J
9. a) 29.4 J
b) 5.42 m/s

page 197
B2.0 Section Review

20. 45.0 J
21. 9.81 J
23. 800 J
25. 5.7 m/s

page 216
Practice Problem

1. 34.9%

page 217
Practice Problem

2. 13 J

page 217
Practice Problem

3. 3.13%

page 220
B3.3 Check and Reflect

5. a) 1000 J
b) 800 J
c) 800 J
d) 200 J
e) 80%
7. 65.7%
8. 4.20×10^3 J
9. 2.80×10^5 J

page 228
B3.0 Section Review

14. a) 3.5×10^2 J

pages 232–237
Unit B Unit Review

8. 26.0 J
31. 2.00 h
32. a) 20.0 m
b) 0 m
c) 5.0 m/s
d) 0.0 m/s
33. 8.33 m/s^2 [N]
34. 2.0 J
36. 500 J
39. 7.19×10^{-3} J
40. 20.0 m/s
41. 1.96×10^3 J
42. 988 m
43. 17.2 m/s
46. 2.19×10^3 m
53. 35.0%
54. 9.33×10^3 J
67. 0.650 m
75. d) 7.5×10^{-3} m/s
76. e) 0
g) 5.3×10^{-2} m
77. 25 J

page 244
Skill Practice

a) 25×
b) 1000×

page 246
C1.1 Check and Reflect
6. 1500 µm
7. 375 µm
8. 50 : 1

page 265
C1.0 Section Review
14. 400 µm
15. 100×

page 289
Practice Problems
1. a) 1.7; b) 1.1
2. $\frac{2lw + 2lh + 2wh}{lwh}$; 3.8
3. $\frac{3}{r}$; a) 1.4 b) 0.70

page 293
C2.4 Check and Reflect
8. a) 96 cm^2; b) 64 cm^3; c) 64 cm^2;
d) 128 cm^2; e)32 cm^3; 64 cm^3
f) surface area increases from 96 cm^2 to 128 cm^2; volume remains the same; surface area: volume increases from 1.5 to 2.0.

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Cell #	Length (cm)	Width (cm)	Height (cm)	Surface Area *(A)* cm^2	Volume *(v)* m^3	Surface Area to Volume ratio *(A/v)*
1	5	3	2	62	30	2.1
2	12	5	1	154	60	2.6
3	40	27	20	4840	21 600	0.22

17. Cell #2

page 335
Unit C Unit Review
39. 300 µm

page 367
Activity D9 QuickLab
2. 30%
3. 100%
4. 70%

page 379
Practice Problems
1. 15.1 kJ
2. 32.3 kJ
3. 1.26 kJ
4. 30.2 kJ

page 380
Practice Problems
5. 20°C
6. water 0.119°C, iron 1.11°C
7. 0.897 J/g·°C
8. 0.130 J/g·°C

page 386
Practice Problems
9. 6.01 kJ/mol
10. 19.2 kJ
11. 2.50 mol
12. 0.385 kJ/mol

page 387
Practice Problems
13. 3.48 kJ/mol
14. 40.7 kJ/mol
15. 1.13×10^3 kJ

page 390
D2.3 Check and Reflect
14. 1.6×10^2 kJ
15. 168 kJ
16. 36.0°C
17. 15.0 g
18. 40.7 kJ/mol
20. 15.0 kJ
21. 12.0 mol

pages 408-409
D2.0 Section Review
32. 37.3°C
33. 14 J
34. 110 g
35. 2.3×10^2 kJ
36. 40.7 J/mol
37. 1.02×10^3 kJ
38. 3.34 kJ

pages 435-439
Unit D Unit Review
85. 4.19 x 10^6 J or 4.19 x 10^3 kJ
86. 25.7°C
87. 15.0 g
88. 0.13 J/g·°C
89. 66.7 J
90. 81.3 J
91. 4.99 mol
92. 63 g

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